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Developing Workplace Injury Index (WII) as a Measure of Safety and Health Performance in the Construction Industry in Malaysia

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Abstract

The construction industry has been generally perceived as being an unsafe and dangerous place of work due to frequent occupational injuries (and fatalities). However, to date, there is no systematic effort in determining the degree of safety and health in this industry. Data on occupational safety and health in this industry are available only in the form of frequency counts but on the severity of injuries. As such, a less meaningful representation of occupational safety and health performance cannot be gauged. Hence, we attempted to develop an index, called Workplace Injury Index, toward this end. To do so, we first identified the common injuries in the construction sector, then ranked them by severity, and finally formulated the index.

Keyword: Workplace Injury Index, Occupational Safety and Health, Construction Industry

1. Introduction

The construction industry is recognized as an important sector of any national economy, especially in relation to its employability potentials. However, the occurrence of workplace accidents, incidents, injuries and fatalities in construction sites around the world are regrettably high (Hinze, 1997). In Malaysia, the number of accidents and fatality rates has made the construction industry one of the highly hazardous industries. Table 1 below shows the number of fatalities resulting from workplace accidents from 2007 to 2011 by industrial categories, as reported by the Social Security Organization (SOCSO) (2012). Even though in general the fatality rates have been marginally decreasing over the years, the table clearly shows that the construction industry registers the highest death rate, contributing to an average of 35% of the total reported fatality rates due to workplace accidents.

Table 1: *Number of Fatality Rates by Industrial Categories (2007-2011)*

Industrial Categories	**2007**	**2008**	**2009**	**2010**	**2011**
Agriculture, Forestry & Fishery	30	42	40	30	41
Mining & Quarry	9	6	2	1	0
Manufacturing	63	76	53	59	45
Electrical, Gas, Water & Cleaning	10	19	18	11	3
Construction	95	72	62	66	51
Trade	3	0	0	0	1
Transportation	2	8	8	14	11
Finance & Insurance Institution	4	4	1	1	6
Public Services	3	2	1	3	7

Source: Social Security Organization (SOCSO) (2012)

It should be noted that statistics obtained from the Social Security Organization (SOCSO) only cover workers subscribing to SOCSO. However, according to the Master Plan for Occupational Safety and Health in Construction Industry 2005-2010, the actual figures may be much higher if those not subscribing to SOCSO are taken into account (www.cidb.gov.my). This is because many workplace accidents among foreign workers in the industry may not be reported to the authorities. In Malaysia, this industry employs a large number of foreign workers who work as manual laborers either legally or illegally. The situation is made worse when the industry employs illegal foreign workers. As such, many workplace accidents go unreported for fearing legal implications faced by the employers.

Occupational safety and health is an important issue but many employers in the construction industry seem unconcerned about to the prospect and success of their company (Dorji, & Hadikusumo, 2006). The high fatality rate in the construction industry creates a negative image and hinders recruitment, especially among local people. In addition, the high rate of workplace accidents also has its implications to the organization's operating cost. For example, frequent accidents and property losses cause delays in operations and other indirect costs as well such as psychological trauma experienced by others at the workplace. An approach to overcome the negative implications is to provide a safe and healthy workplace. But, in order to know the level of safety and health performance of an organization, a measure should be in place. Without such measure and understanding, efforts needed to circumvent occupational injuries and accidents at work may be fruitless, as resources may not be properly channeled and not sufficiently allocated toward this end.

Currently, in Malaysia the Social Security Organisation (SOCSO) and the Department of Occupational Safety and Health (DOSH) gather data on the frequency of workplace injuries/accidents. But, collecting such data alone is insufficient because it does not capture the severity of the workplace injuries/accidents. As a result, a meaningful representation of the actual safety performance in the construction sector cannot be gauged. Given the significance of OSH management at the workplace, it is unfortunate that serious academic attention has been neglected on such a measurement issue particularly in Malaysia. Having a workplace injury index that is more accurate has a number of benefits. With such measure available, an informed and valid comparison of companies within the construction industry can be made. Also, using the measure, a collective safety and health climate of the construction industry can be discerned. With such insight, mitigation strategies in order to provide a safe work environment within the company can be developed. The measure is also useful for policymakers as it allows them to monitor the overall safety climate and hence design some relevant measures.

In essence, this study intends to develop an OSH performance measure that can give a meaningful indication of the safety and health level of employees at the workplace in the construction industry. To develop such measure, we adopted the procedure carried out by previous work that aimed to develop a somewhat similar measure but for a different industry (Ali, Abdullah, & Subramaniam, 2005). Toward meeting such objective, this paper is organized as follows. The next section reviews relevant literatures on the topic of safety measures. Then, a three-stage procedure detailing how the index was developed is offered. Finally, some concluding remarks are presented.

2. Literature Review

To date no objective measure of occupational safety and health in the construction industry is available in Malaysia, although attempts have been made to identify common injuries or accidents within different industries. One of those studies was conducted by Ali et al. (2009) on 68 Malaysian companies over three years from 2001 to 2003. In their observation of injury rate, the severity of 24 musculoskeletal injuries was investigated, out of which scratch was found to be the least severe while deep burn with >50% to be the most severe. However, despite their ability to identify and rank the most common injuries in the manufacturing companies, their instrument is not suitable to be used specifically in the construction industry. This is because the common injuries in both the sectors are not the same due to the risk factors present at the workplace.

Bakhtiyari et al. (2012) examined the pattern of occupational accidents among workers and drivers who had a work-related accident during 2001–2005 in Iran. The study assessed 86,437 work-related accidents during that period. Subjects were analyzed through ordinal logistic regression model (proportional odds regression model) and the study reported more frequent accidents in metal workplaces and electrical industries where more than half of the accidents were due to incautious activities. Barss, Addley, Grivna, Stanculescu, and Abu-Zidan (2009) developed occupational injury patterns within foreign construction, farm and industrial workers in the United Arab Emirates. Prevention-related variables over three years 2003 to 2005 were analyzed using SPSS and severity was quantified by injury severity scores (ISS). ISS was calculated as a single aggregate score for all bodily injuries derived manually using the Anatomical Injury Score (AIS). The researchers identified various types of injuries: machinery/power tools-based, animal-related, burns, and others (road traffic, assault, etc.). Severities of injury assessed by ISS showed clear extremities in occupational injuries.

Schwatka, Butler, and Rosecrance (2012) found that musculoskeletal disorders were common types of injuries in the construction industry because of the precarious and physically challenging nature of work conditions. The study concluded that further investigation should be done to investigate the injury type and severity of this occupation risk in construction sectors because of its effect on overall productivity. In a different study, Cheng, Leu, Cheng, Wu, and Lin (2011) through data mining method known as classification and regression tree (CART) investigated the causes and distribution of occupational accidents regarding serious occupational accidents in the Taiwanese construction industry. They observed that fall/tumble was the most common cause of injuries among all accident types.

Previous studies on injury/accident types at work were generally interested in understanding the causes or factors that contribute toward the injuries. For instance, Arquillos, Romero, and Gibb (2012) evaluated the causes of construction accidents and the severity of the accidents within the period of between 2003 and 2008 in Spain. One of the significant findings was that fatal accidents occurred in both large and small companies and more accidents occurred away from the usual workplace. Bahn (2013) in an investigation of 77 employees of an underground mining operation in Western Australia aimed to identify strategies to control hazards. Three types of hazard were identified: obvious, emerging, and hidden hazards. The most commonly identified obvious hazards include moving machinery, unsupported ground, faulty equipment, misfires/explosives, slips and trips, and incorrect personal protective equipment (PPE). He further identified 23 emerging hazards including faulty machinery, and fatigue/boredom. Hidden hazards were identified such as gas leaks, hydraulic pressure, electrical faults, underground water hazards, human behavior and lack of knowledge, uncontrolled ground movements, unsupported ground, and weather conditions. He argued that by identifying the hazards, occupational accidents and injuries can be prevented.

Amirah, Asma, Muda, and Amin (2013) showed the importance of occupational safety and health in reducing risk at the workplace. They examined the high accident rate in manufacturing industries in Malaysia and concluded that lack of safety culture and non-compliance inadvertently led to workplace hazard. This finding corroborates the finding of Ali et al. (2009), who observed that the reduction of accident rate was the result of compliance to safety management system.

In sum, as can be seen from the relevant literatures above, no single measure to gauge the severity of workplace accidents is available. Barr et al.'s (2009) work is the closest to the present study in that they quantified severity by injury severity scores (ISS) to rank the severity of the injuries. However, the present study took the issue further by developing a measure to gauge an organization's safety performance by assessing the severity of injuries reported.

3. Method and Result

In developing a measure of occupational safety and health, we observed the following three-stage procedure.

1.1 The First Stage: Injury Identification

The first stage involves producing a list of injuries. In this stage, the following steps were taken.

First, we identified injuries sustained by employees in the construction sector. To do so, a comprehensive list of injuries was drawn up based on the PERKESO (SOCSO) Annual Report (2012), resulting in a list of more than 50 injuries. Then, we compared our list with that produced by the International Labour Organization Report III Statistics of Occupational Injuries (Report III: Statistics of occupational injuries, 1998). Based on the comparison, we drew a list of 52 injuries.

Next, we identified the common injuries sustained in the construction industry with the help of three experts in the field of occupational safety and health. The first expert was a senior officer at the Department of Occupational Safety and Health (DOSH) in Kedah that handles accident investigations. The second expert was a senior officer attached to the Putrajaya DOSH office responsible for policy and research. The third expert was a senior officer from SOCSO or PERKESO head office in Kuala Lumpur responsible also for policy and research. We presented the list of 52 injuries derived from the ILO and PERKESO reports to these experts and asked them to identify the most common injuries sustained in the construction industry. After several rounds of discussions with them, the original list of 52 injuries was whittled down to 30 common injuries, shown in Table 2.

As shown in Table 2, eight categories of injuries are identified. They are fracture of limb, amputation of limb, crushing of limb, poisoning, burn, electrical hazard, biological, and physical injuries.

Table 2: *Common Occupational Injuries*

Injury	**Type**
Fracture of upper limb	Fracture
Fracture of lower limb	
Amputation of upper limb	Amputation
Amputation of lower limb	
Crushing of upper limb	Crushing
Crushing of lower limb	
Poisoning through splash	Poisoning
Poisoning through ingestion	
Poisoning through inhalation	
Poisoning through bites by venomous animal	
Superficial burn (less than 50%)	Burn
Superficial burn (more than 50%)	
Deep burn (less than 50%)	
Deep burn (more than 50%)	
Electrocution	Electrical
Electrical shock	
Bites of non-venomous insects	Biological
Scratch	Physical
Abrasion	
Bruise	
Blister	
Laceration	
Strains	
Sprains	
Contusion	
Dislocations	
Concussions	
Radiation	
Injury to Eye	
Asphyxia	

1.2 The Second Stage: Ranking of Injury

The second stage involves ranking of the injuries to determine the severity of the 30 injuries, ranging from '1' "not severe" to '30' "extremely severe" (Vredenberg, 2002). The ranking of the injuries was done by experts who are physicians specializing in occupational health. To identify these physicians, a list of all the doctors qualified as occupational health doctors and registered with DOSH was obtained. Based on the DOSH 2012 Register, there were 458 doctors registered as occupational health doctors. Due to some limitations, we decided to select a sample of 210 registered doctors, based on Krejcie and Morgan's (1970) sample size recommendation. But, to ensure that we obtained a good response rate, we chose 350 occupational health doctors using a simple random technique.

After the required sample was drawn, we requested the participants to rank the severity of the 30 common injuries in the construction industry on the questionnaire sent out to them. But, the injuries were listed in no particular order. The participants were instructed to rank the 30 injuries from '1' "Not Severe" to '30' "Extremely Severe". They were told to take into consideration the extent to which the injury may affect factors such as days off from work, permanent or long-term inability to perform job duties, medical expenses, as well as whether the injury is life threatening when ranking the severity of the injuries. Included in the questionnaire pack was a self-addressed postage paid envelope to be used by the participants to return the completed questionnaire. A total of 104 questionnaires were returned. However, 32 questionnaires were unusable because they had incomplete rankings. Therefore only 72 questionnaires with complete rankings were usable for the analysis giving a response rate of 20.6%.

Table 3 shows the severity ranking of common injuries from '1' "Not Severe" to '30' "Extremely Severe." Seven types of injuries caused by physical hazard (i.e., scratch, abrasion, bruise, blister, laceration, strains, and sprains) were ranked as being the least severe injuries observed in the construction industry. The top five extremely severe injuries in order were asphyxia, deep burn (more than 50%), electrical shock, deep burn (less than 50%) and crushing of lower limb.

Table 3: *Severity Ranking*

Severity	Injury	Type
1.	Scratch	Physical
2.	Abrasion	
3.	Bruise	
4.	Blister	
5.	Laceration	
6.	Strains	
7.	Sprains	
8.	Bites of non-venomous insects	Biological
9.	Contusion	Physical
10.	Dislocations	
11.	Concussions	
12.	Fracture of upper limb	Fracture
13.	Poisoning through splash	Poisoning
14.	Poisoning through ingestion	
15.	Poisoning through inhalation	
16.	Radiation	Physical
17.	Fracture of lower limb	Fracture
18.	Superficial burn (less than 50%)	Burn
19.	Poisoning through bites by venomous animal	Poisoning
20.	Injury to eye	Physical
21.	Superficial burn (more than 50%)	Burn
22.	Electrocution	Electrical
23.	Amputation of lower limb	Amputation
24.	Amputation of upper limb	
25.	Crushing of upper limb	Crushing
26.	Crushing of lower limb	
27.	Deep burn (less than 50%)	Burn
28.	Electrical shock	Electrical
29.	Deep burn (more than 50%)	Burn
30.	Asphyxia	Physical

1.3 The Third Stage: Formulating the Workplace Injury Index

The rankings obtained from the 72 occupational health doctors were analyzed using the Thurstone's Discriminate Model (McIver & Carmines, 1981). The rankings given were converted to an interval scale ranging from '1' "Not Severe" to '30' "Extremely Severe" and

entered into an Excel spread sheet. The final spread sheet comprised a 72 x 30 matrix. Then the frequency counts of the severity of each injury was computed based on the scale. For instance, the least severe injury was determined by counting the highest frequency of '1'. We found that "Scratch" had the highest frequency of 1 (i.e. 37). As such "Scratch" emerged as the least severe injury. Similar procedure was used to determine the most severe injury. We found that "Asphyxia" had the highest count of 19 compared to the other injuries. Thus "Asphyxia" was determined as the most severe injury. The same process was repeated for all other injuries in a descending order from 1 to 30.
Based on the severity ranking, an index was developed by weighting the frequency of injury with its severity. This would enable the computation of a uniform score of workplace safety performance in the construction sector. This would also serve as a measure to calculate safety performance score.

We call the index the Workplace Injury Index (WII), which was calculated as per the equation below, where X_1-X_{30} denotes the common injuries in the construction sector, from being "Not Severe" to "Extremely Severe." The numerical value of 1-30 represents the severity of injuries, as ranked by experts.

$$\mathbf{WII = 1X_1\,(n) + 2X_2\,(n) + 3X_3\,(n) \ldots 30X_{30}\,(n)}$$

Where

WII: Workplace Injury Index

X_1-X_{30}: Type of injuries in the order of severity from '1' "Not Severe" to '30' "Extremely Severe"

n: Frequency of injuries sustained for each type of injury

X_1: scratch; X_2: abrasion; X_3: bruise; X_4: blister; X_5: laceration; X_6: strains; X_7: sprains; X_8: bites of non-venomous insects; X_9: contusion; X_{10}: dislocations; X_{11}: concussions; X_{12}: fracture of upper limb; X_{13}: poisoning through splash; X_{14}: poisoning through ingestion; X_{15}: poisoning through inhalation; X_{16}: radiation; X_{17}: fracture of lower limb; X_{18}: superficial burn (less than 50%); X_{19}: poisoning through bites by venomous animal; X_{20}: injury to eye; X_{21}: superficial burn (more than 50%); X_{22}: electrocution; X_{23}: amputation of lower limb; X_{24}: amputation of upper limb; X_{25}: crushing of upper limb; X_{26}: crushing of lower limb; X_{27}: deep burn (less than 50%); X_{28}: electrical shock; X_{29}: deep burn (more than 50%); X_{30}: asphyxia

4. Discussion and Conclusion

The purpose of this study was to develop a workplace injury index because the current practice of reporting workplace injury relies on the frequency of occurrences without incorporating the severity of the respective injury. Furthermore, no systematic endeavors have been made to develop a performance index of safety at the workplace in the construction industry. This study has attempted to do that by including severity of injury to give a meaningful representation of the actual workplace safety scenario in the construction industry. This was done through a rigorous scientific approach whereby the severity of the injury was ranked by Occupational Health Doctors (OHD) who have vast experience dealing with workplace injury. The injuries were ranked from '1' "Not Severe" to '30' "Extremely Severe". Less severe injuries include bruise, abrasion and scratch, while extremely severe injuries include crushing of lower limb, deep burn, and asphyxia.

Next, an index called Workplace Injury Index (WII) which can be a meaningful indicator of safety performance for the construction industry, was formulated. The WII is determined by multiplying the frequency of occurrence of the 30 common injuries with the severity ranking of each type of the injuries. The WII will provide a strong indicator of the level of safety performance of companies in the construction sector.

Although the index was developed in such a way that rigor was ascertained, it is important that the applicability of the index is validated. Hence, we would recommend that safety data from construction companies be collected. Once the applicability is not suspect, we would suggest that the DOSH use this index to establish a general norm of safety performance of the construction industry in Malaysia. Besides that Safety and Health Officer (SHO) could use this index as a mandatory reporting of safety and health related matters to the relevant agencies. Construction companies could also use this index to project a safe and healthy image, which in turn would attract especially local citizens to work in this industry. Hence issues of overreliance on foreign workers could be partially resolved. This approach could also be adapted to other industries so that a comprehensive index comprising of all major sectors of the economy could be developed to assist the Department of Occupational Safety and Health (DOSH) and Social Security Organization (SOCSO) develop an Occupational Safety and Health (OSH) master plan for the country.

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